The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
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IAEA
International Atomic Energy Agency

2242-11

Joint ICTP-IAEA Workshop on Uncovering Sustainable Development CLEWS; Modelling Climate, Land-use, Energy and Water (CLEW) Interactions

30 May - 3 June, 2011

Water Assessment Dynamics

YOUNG Charles

Stockholm Environment Institute Davis
133 D Street, Suite F
Davis CA 95616
U.S.A.

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Charles Young

Stockholm Environment Institute

SEI STOCKHOLM ENVIRONMENT INSTITUTE

Introducing the Stockholm Environment Institute (1)

- Key Facts:
  - Founded in 1989 at the request of the Government of Sweden
  - Emerged from a long-term research collaboration between the University of Stockholm and the University of York on issues related to acid rain mitigation in Northern Europe.
  - Receives some core support from the Government of Sweden.
  - Raises the majority of its funds through sponsored research grants.
  - Approximately 160 researchers worldwide.

Introducing the Stockholm Environment Institute (2)

- Four Research Themes:
  - Managing Environmental Systems
  - Reducing Climate Risk
  - Transforming Governance
  - Rethinking Development

Introducing the Stockholm Environment Institute (3)

- Seven Research Centers:
  - Stockholm, Sweden (Headquarters)
  - York, United Kingdom
  - United States (Boston, Davis, Seattle)
  - Tallinn, Estonia
  - Oxford, United Kingdom
  - Asia (Bangkok)
  - Africa (Dar es Salaam)

SEI-US Water Group

- 10 researchers
- Engineers, scientists, and an economist
- Focused on efforts to promote integrated water resources planning and management
- Known best for 15 years of effort developing and applying the Water Evaluation and Planning (WEAP) system.

Outline

- Water Supplies
- Water Demands
- The Challenges
- The Approaches
- The Tools

Water Supplies

Water Supplies

- Rainfall
- Stream flow
- Groundwater
- Sea water
- Return flows

Water Supply Considerations

- Quantity and timing of availability
- Location
- Quality
- Water rights

Water Demands

Water Demands (1)

- Domestic
  - Human consumption
  - Cooking
  - Washing
  - Sanitation
  - Outdoor gardening/landscaping

Water Demands (2)

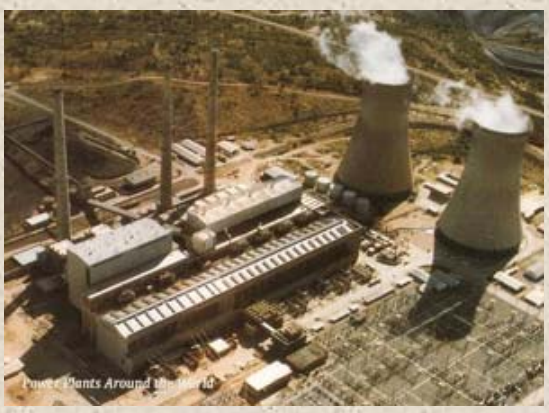
- Agricultural (the L in CLEW)
  - Crop evapotranspiration
  - Salinity control
  - Climate control
  - Seedbed preparation

Water Demands (3)

- Commercial/Industrial
  - Food preparation
  - Sanitation
  - Industrial processes

Water Demands (4)

- Energy Production (the E in CLEW)
  - Hydropower
    - Carbon free energy
    - Obstruction of fish migration
    - Alteration of downstream flows
    - Alteration of sediment transport
  - Power plant cooling
    - Return water is warmer



Water Demands (5)

- Environmental Demands
  - Riparian organisms
    - Flow rate and timing
    - Temperature
    - Water quality
  - Physical riparian processes
    - Sediment transport
    - Flood recession

Water Demands (6)

- Controlled Flood – Colorado River, USA
  - Operation of Glen Canyon Dam limited movement of sediment and variations in water temperature.

Water Demands (7)

- Cultural/Religious
  - Some sources of water are sacred and can not be utilized for other purposes.

Planning Challenges

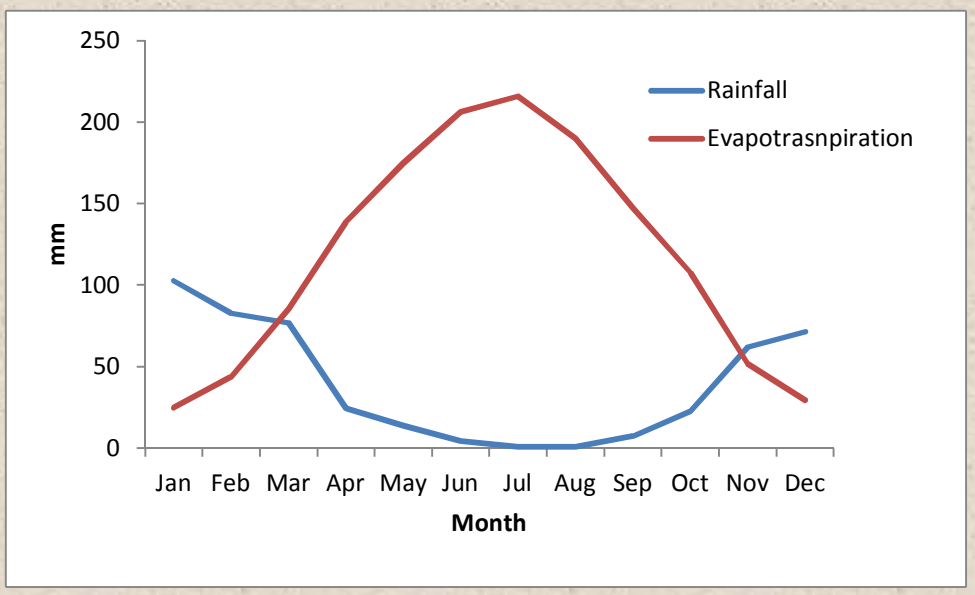
Water Resources Planning Challenges (1)

- Basic Issues
  - How much is needed?
  - When and where is the water needed?
  - When and where is it available?
- Economic Considerations
- Environmental Considerations
- Political Considerations
- Societal Considerations
- Uncertainty

Water Resources Planning Challenges (2)

- Basic Issues
  - When is the water needed?

Example: Sacramento Valley, California



Water Resources Planning Challenges (3)

- Basic Issues
  - Where is the water available?

Example:

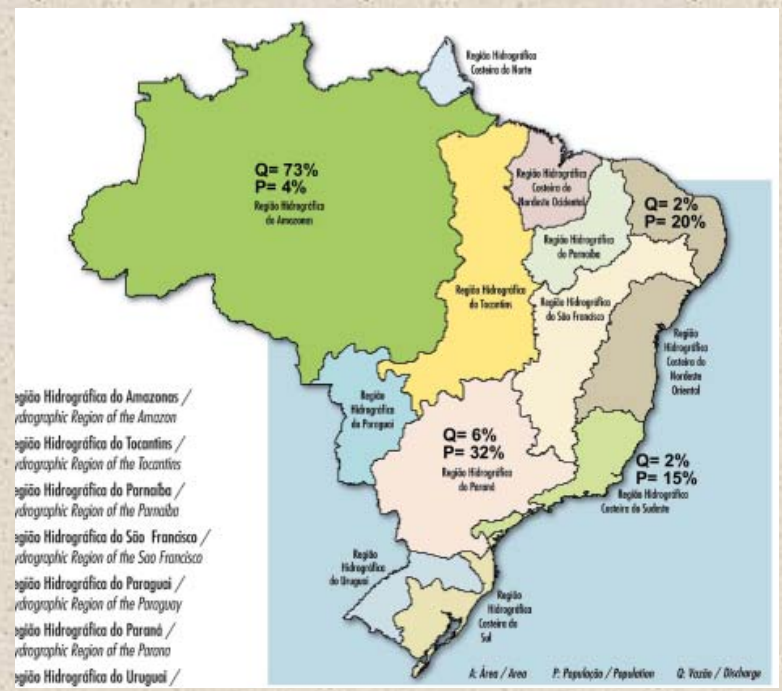
Sacramento Valley, California

Water Resources Planning Challenges (4)

- Basic Issues
  - Where is the water available?

Example:

Brazil



Water Resources Planning Challenges (5)

- Economic Considerations
  - How much can be spent on the planning process?
  - Will the proposed solution be a net benefit to the economy?
  - Will maintenance of the system be sustainable?

Water Resources Planning Challenges (6)

- Environmental Considerations
  - How will diversions affect ecosystems?
  - Will return flows be polluted?
  - Will damage to downstream ecosystems negatively impact others?

Water Resources Planning Challenges (7)

- Political Considerations
  - Village level politics
  - National plans versus local needs
  - International boundaries

Ethiopia rejects Egypt Nile claims – Al Jazeera 19/5/10

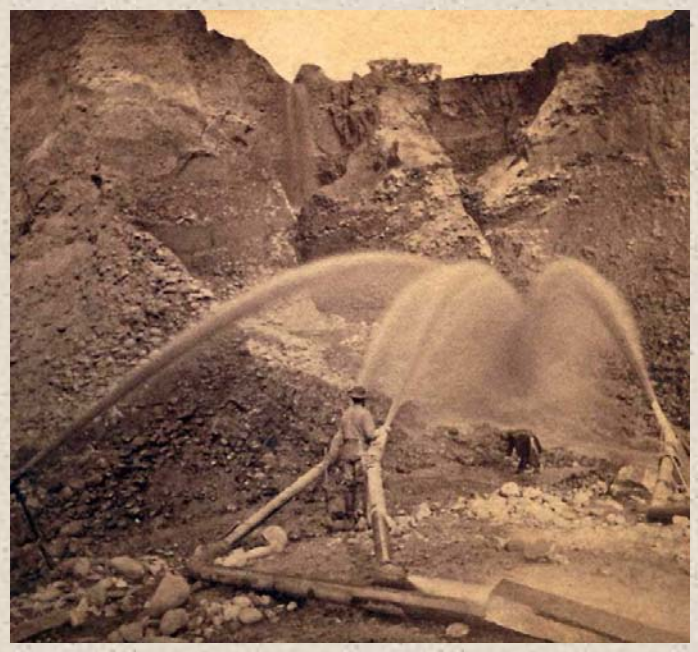
Water dispute increases India-Pakistan tension – NY Times 20/7/10

Water Resources Planning Challenges (8)

- Societal Considerations
  - Changing values
  - Competing demands for water
    - Fish vs. farming
  - The interconnectedness of systems
    - People's livelihoods may or may not be improved by water development

  Watershed planning, Integrated WRM, Adaptive Management

Water Resources Planning Challenges (9)



- Societal Considerations

  Example:

  Hydraulic Mining in California

  Massive use of water for mining resulted in downstream flooding and burial of farm land.

  In 1884 – a grossly polluting industry was shut down for the public good.

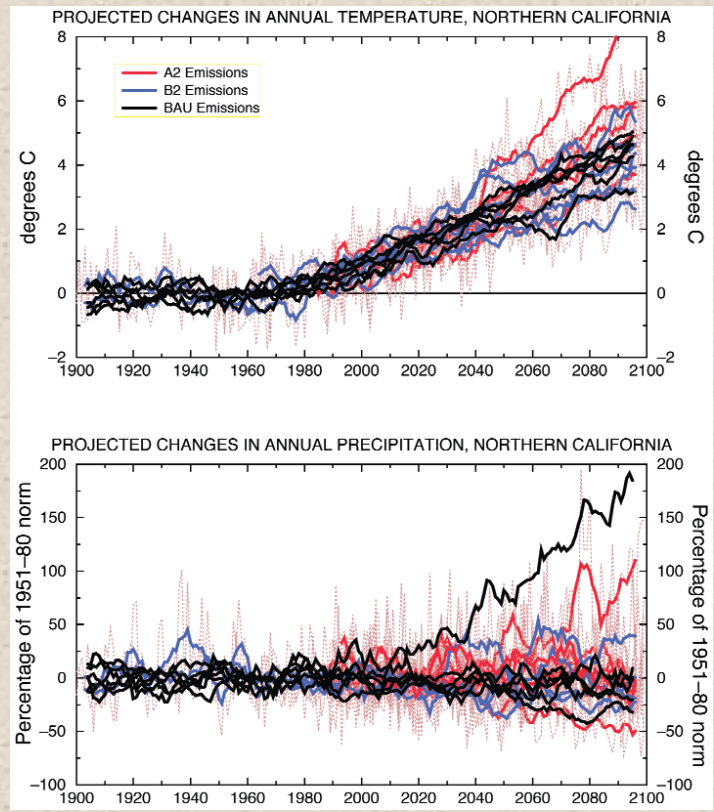
Water Resources Planning Challenges (10)

- Climate Uncertainty (The C in CLEW)

Example:

Projected climate in California

By 2100 temperature will increase by 2 to 8+ degrees. Precipitation will change by -50% to 200%.



Source: Dettinger, 2005

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Planning Approaches

Source: Approaches to Planning Water Resources – Dr. Jay Lund, University of California at Davis

Rational Planning

- Inventory of knowledge
- Statement of performance objectives
- Identification of alternative solutions
- Evaluation of alternatives on stated objectives
- Implementation and pragmatic revision
- Periodic re-examination

Approaches to Planning Water Resources

- Requirements based planning
- Benefit cost based planning
- Multi-objective based planning
- Conflict resolution planning
- Market based planning
- Muddling through

Requirements Based Planning

- Define functional specifications for the system
- Design, build, and operate at lowest cost and greatest reliability

Challenges

- Assumes fixed demands
- Focus is on supply side
- Used when costs of shortages exceed costs of supply

Benefit-Cost-Based Planning

- Benefits should exceed costs

Challenges

- Difficult to monetize all benefits and costs
- Selecting discount rates
- Incorporating social equity
- Representing risk

Multi-Objective Planning

- Attempt to show decision makers the trade-offs inherent in alternative selection when objectives are measured in different units.

Challenges

- Difficult to communicate trade-offs to decision makers

Conflict Resolution Planning (1)

- Used in cases where there is conflict.
- Often involves political players.
- Focus is on communication, education, and consensus, not necessarily technical optimization.

Conflict Resolution Planning (2)

- Adaptive management
  - Centered on a consensus understanding that is updated as time progresses
- Watershed planning
  - Focused on including all stakeholders and all issues, i.e. quantity and quality of water

Conflict Resolution Planning (3)

Challenges

- Political players can change direction of or abandon process
- Time
- Money

Market Based Planning

- Creation of markets for a limited resource (water) can lead to economically efficient allocation of the resource.
- Can provide for flexible operations that respond to changing conditions

Challenges

- Assignment and accounting of water rights
- Externalities

Muddling Through

- Used when political and economic situation will not support long-term planning efforts
- When political/economic situation is unstable, smaller projects working towards a larger goal may be possible
- Can be responsive to changing goals and understanding of problem

Models in Water Resources Planning

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How can models help? (1)

Constructing a model can:

- Create a central repository for data.
- Lead to a common understanding of the problem

How can models help? (2)

A model can be used to:

- Test hypotheses
- Simulate management scenarios
- Determine relative importance of specific actions

Model Selection (1)

- Study your problem
  - What physical processes need to be represented?
  - What time step is required?
  - Are there existing models/studies?
- What questions do you want to answer?
- How will stakeholders interact with the model?

Model Selection (2)

- What is the skill of your modelers?
  - Should you hire consultants?
- What is the budget for modeling?

Summary

Summary

- Demands for water are numerous and can change over time.
- Planning must consider timing and location, economic, environmental, social, political, and uncertainty issues.
- There are many approaches to planning. The proper approach will depend on your problem.
- Models can serve as useful tools in the planning process.

Thank You!